The Spatial Video Acquisition System as an Approach to Capturing Damage and Recovery Data After a Disaster: A Case Study from the Super Tuesday Tornadoes

Jacqueline W. Mills[1], Andrew Curtis[1], William Fagan[2], Chelsea Core[3]

[1]GIS Research Laboratory, Department of Geography, University of Southern California
[2]Disaster Science and Management Program, Louisiana State University
[3]Department of Geography and Anthropology, Louisiana State University

Background to the Problem and the Approach

The Super Tuesday 2008 tornadoes struck the Mid-South from central Arkansas to central Tennessee and from Kentucky to Mississippi. The regional scale of these incidents makes this tornado disaster unusual in the United States. However, it also provides an opportunity to study the geographic variability in damage and subsequent recovery. This report documents the use of an emerging geospatial technology, the Spatial Video Acquisition System (SVAS), as a tool to systematically collect data after a disaster. Though the resulting datasets may be used for many purposes, the primary interest of our work is in using SVAS is 1) as a damage assessment methodology and 2) as a way to capture spatial patterns of subsequent recovery. The need exists for systematic data to be collected throughout the course of a disaster, from response to recovery (Mileti 1999). These data must also be collected in a standardized way and in a format that can be archived so that they can be used in longitudinal and comparative studies. This report provides an overview of the SVAS as an approach to gather these data. It also serves to document its use in a post-tornado environment, and provides an assessment of its benefits and limitations in this situation.

Spatial Video Acquisition System (SVAS)

The Spatial Video Acquisition System (SVAS) was developed through the National Center for Geocomputation (NCG) in Maynooth, Ireland. For the past two years NCG has collaborated with Louisiana State University (LSU) and the University of Southern California (USC) to test the utility of SVAS for damage assessment and recovery data collection in post-disaster environments. A LSU/USC team has been using the technology in Orleans and St. Bernard Parishes in Louisiana, while USC has taken SVAS into burn areas of San Diego County, California. In brief, SVAS consists of digital video cameras linked to a GPS receiver through their audio channels. The cameras are mounted on the windows of the field vehicle, for example, one on each side and one facing forward (Figure 1). As the vehicle drives the impacted area, each frame of the video is tagged with a coordinate. After processing the data through NCG software, the resulting video frames and coordinates are accessible in a database that is compatible with use in a Geographic Information System (GIS). Therefore, indicators of damage, for example a missing roof or a house off its foundation, can be created in the GIS for visualization and analysis of the spatial patterns of damage. Subsequent data collection trips can also re-visit the same areas to compile indicators of recovery, such as rebuilding. For a complete description of SVAS, see Curtis et al. 2007(a).

Study Areas

Upon reading about the tornadoes that impacted the Mid-South on Tuesday, February 5, we made flight arrangements to travel from Los Angeles to Memphis and also to have our collaborators drive from Baton Rouge to Memphis. We all arrived on Friday, February 8. Due to the short time period between the events and our travel, the information on the extent of damage was still forthcoming; therefore we based our study areas upon the most comprehensive data at that time, coordinates from the National Weather Service (NWS) of tornado incidence (Figure 2). After bringing these coordinates into a GIS we were able to determine those areas that could be surveyed while using Memphis as our base for fieldwork (Figure 3).

Based on the NWS coordinates, we identified several specific study areas: 1) Jackson, Tennessee (medium sized town), 2) Memphis, Tennessee (urban area), 3) DeSoto County, Mississippi (suburban area), and 4) east central Arkansas (rural area). We intended to capture damage and early recovery data for each of these areas in order to compare ways in which the underlying geography of a place may impact recovery. However, based on local news reports collected upon arriving in our first study site, Jackson, we shifted the focus of our limited time in the field to Jackson, Memphis, and a small area of residential destruction, Huntersville, Tennessee.

We began our fieldwork on Saturday by driving approximately eighty miles from Memphis to Jackson where several tornado incidents had been identified by NWS. Given news reports of the extent of damage to Union University, we began collecting data with SVAS in a nearby neighborhood and then throughout the accessible parts of the campus. However, the majority of tornado damage occurred on the university property and given our focus on residential damage and recovery, we decided to pursue other leads. While in Jackson, we obtained a copy of the local newspaper, the *Jackson Sun*, which displayed a photograph of catastrophic damage in the small nearby town of Huntersville. Though we intended to capture data in each of the four areas mentioned above, we spent the majority of our time in Memphis, Jackson, and Huntersville, with Huntersville being the most suitable for longer term investigation of recovery through SVAS due to its finite geographic extent and the range of damage in that area.

Huntersville is a small rural area outside of Jackson that was devastated by the tornadoes, with two deaths occurring in this community (Figure 4). Many of the homes in this community were damaged to some degree, with several being completely destroyed. Huntersville, however, was not an area designated by NWS as receiving direct impact from a tornado, as of Wednesday, February 6. This experience highlighted the need to consult local news in addition to formal federal reports and data, particularly in events that are capricious in nature, such as tornadoes. Many places may be damaged, but escape the immediate or initial attention of major news sources.

Preliminary Findings

Field data collection in a post-tornado environment with SVAS presents some benefits and challenges not experienced in our existing work in post-Katrina Louisiana and in the burn areas of southern California. Regarding benefits, in Louisiana and California SVAS is being used to capture recovery, but that process did not begin until many months had passed after the disasters. So, although still beneficial for studies of recovery, we were not able to capture the earliest acts of this process, e.g. clean-up. Gathering data on the first stages of recovery is important in that not only are the acts of recovery documented, but also who is involved in early in this process. From our work in Huntersville, Tennessee, for example, we captured not only the removal of debris from houses, but also the vans of church groups who were helping with the clean-up. In fact, the faith-based community appeared central to the clean-up and early recovery process in this small town. Another benefit of using SVAS immediately after an event is that it can serve as a management tool for effective (and cost-effective) damage assessment. Curtis et al. (2007a) provide an example of how SVAS can improve standard methods used by Red Cross Disaster Assessment Teams.

However, we also experienced several challenges regarding the use of SVAS in an immediate post-tornado environment. First, the Mid-South tornado impact areas presented the challenge of being identified, which has already been addressed. Second, GPS reception was variable in some areas of western Tennessee. In a large survey area this problem could have detrimental effects on linking the video back to coordinates. However, due to the small study areas and our use of waypoints via another GPS unit, we were able to tie coordinates to the video frames missing this information. Third, in several cases, impacted areas were great distances from one another, which limited the amount of field data collection that could be accomplished each day. Of course, this limitation could be remedied by deploying multiple teams with SVAS in their vehicles. However, this point does relate back to the first obstacle of identifying impacted areas from the road in that many miles were driven around coordinates of tornado incidence and not always with a successful conclusion of finding the damaged areas. Again, though NWS coordinates were useful for planning purposes, local news reports were actually a better source for where to use the SVAS.

SVAS has been employed in both Katrina and southern California wildfire recovery studies, though data collection for the Katrina-impacted areas is ongoing now for nearly two years in comparison to only being in the first month of surveying in the southern California areas. Though hurricanes, flooding, and wildfire produce different post-disaster landscapes and occur in places with differing underlying geographies, i.e. dense urban settlement as compared to more dispersed rural domiciles, use of SVAS as a survey of the visual impact of an event captures aspects of the built environment, i.e. damage and recovery, as well as human interaction with these places, i.e. signs of hope or despair such as people clearing debris together and spray painted messages on buildings. In Katrina, finding suitable areas to deploy this technology was not difficult. Indeed, due to the continuous nature of the destruction, the choice of areas was overwhelming. In the case of the southern California wildfires, however, more distinct areas were easily chosen based on the geographically finite places where fire and residences coincided. With a tornado or series of tornadoes, finding suitable study areas is more challenging. However, from using SVAS for the Mid-South tornadoes we are able to extract the following types of data which can then be analyzed in a GIS: 1) description of structural damage, 2) extent of debris fields, 3) additional damage, i.e. to automobiles, and 4) debris removal (both where is it occurring and who is doing the work such as a church group). These data can begin to build a more comprehensive picture of damage and recovery in that the methodological approach can be used in a variety of events and in different geographies. Though, it is important that the collection process begin as soon as possible after an event due to the dynamic and perishable nature of these data. We expect our findings from this study to contribute to a model of recovery that can be extrapolated to other rural areas, but also as a model for recovery in general, especially when incorporated with findings from our ongoing work with Katrina and the southern California wildfires.

Discussion and Future Directions

A number of gaps exist in the study of disasters. Our work with SVAS in the Super Tuesday tornadoes addresses two of these issues. First, as a result of inadequacies in data collection, we lack a replicable, systematic method of studying disasters. The existing work on recovery has been undertaken mostly without a spatial component, which neglects to account for the spatial patterns that are being recognized in post-Katrina New Orleans (Curtis et al. 2007a, b). Second, urban America provides the study areas for most hazards research even though rural places are plagued by a variety of risks, including tornado activity in the central United States. Our continuing research in the Mid-South will address these gaps. In addition, again because of limitations in the ability to collect data at different periods (Norris 2002), many studies only collect data for one phase after the disaster, even though it is acknowledged that recovery and impediments to recovery, are all phase dynamic and do not simply “behave” as a linear function from the time of the event (Marshall et al. 2007, van den Berg et al. 2005, Kimhi and Shamai 2004). Spatial patterning is, arguably, even more important in post-tornado environments than other disasters due to the often-heterogeneous nature of damage. Impacted neighborhoods may have three types of “damage” structures – the destroyed home that has neighbors with destroyed homes. The single destroyed home with neighbors that are undamaged or with slight damage, and the undamaged or slightly damaged house with neighbors that are destroyed. All of these situations have immediate implications for neighborhood and personal recovery in terms of decisions to return or related issues of psychopathology. For example, return or lack of return can then be indicated by visual characteristics, such as lights on in the home at night. As a result, areas with only a few returnees could be targeted for psychological support. In conclusion, recovery is manifest in the built environment and its indicators are spatial and visual which makes SVAS a useful approach to capturing damage and subsequent recovery data in a post-disaster environment.

References

Curtis, A., JW Mills, B Kennedy, S Fotheringham, and T McCarthy. 2007(a). Incorporating a Spatial Video Acquisition System into Disaster Response and Recovery: *A Case Study of the Lower 9th Ward. Journal of Contingencies and Crisis Management* 15(4): 208-219.

Curtis A, JW Mills, M Leitner. 2007(b). Katrina and Vulnerability: The Geography of Stress. *Journal of Health Care for the Poor and Underserved* 18(2):315-330.

Kimhi S, M Shamai. 2004. Community resilience and the impact of stress: Adult response to Israel's withdrawal from Lebanon. *Journal of Community Psychology* 32(4):439-451.

Marshall GN, TL Schell, MN Elliott, NR Rayburn, LH Jaycox. 2007. Psychiatric disorders among adults seeking emergency disaster assistance after a wildland-urban interface fire. *Psychiatr Serv* 58(4):509-14.

Mileti, DS. 1999. Disasters by Design: A Reassessment of Natural Hazards in the United States. Washington: National Academies Press.

Mills, JW, A Curtis, JC Pine, B Kennedy, F Jones, R Ramani, and D Bausch. The Clearinghouse Concept: A Model for Geospatial Data Centralization and Dissemination in a Disaster. *Disasters* (in press).

Mills, JW. Understanding Disaster: GI Science Contributions to the Ongoing Recovery from Katrina. Guest Editorial in *Transactions in GIS* (in press).

Norris FH. 2002. Disasters in urban context. *Journal of Urban Health* 79(3):308-14.

van den Berg B, L Grievink, J Yzermans, E Lebret. 2005. Medically unexplained physical symptoms in the aftermath of disasters. *Epidemiol Rev* 27:92-106.

Figures

Figure 1. Example of SVAS Installation

Figure 2. Locations of Tornado Events as Reported by National Weather Service.

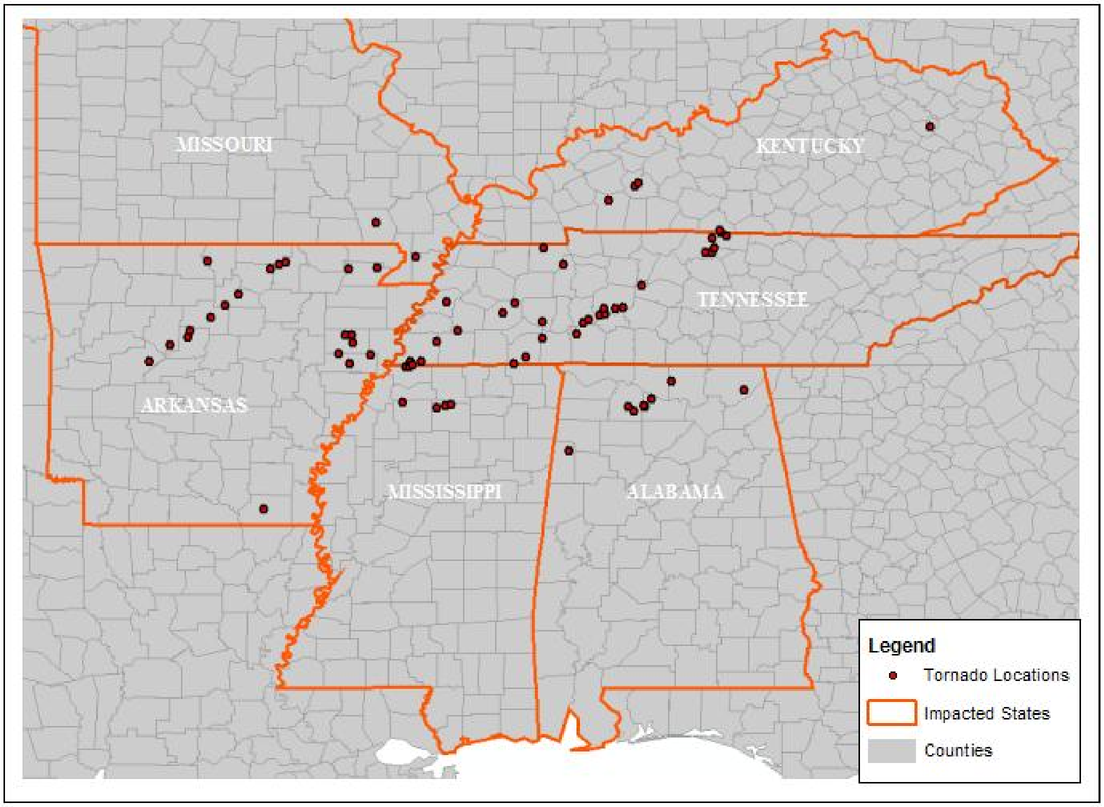

Figure 3. Study Areas for Field Data Collection

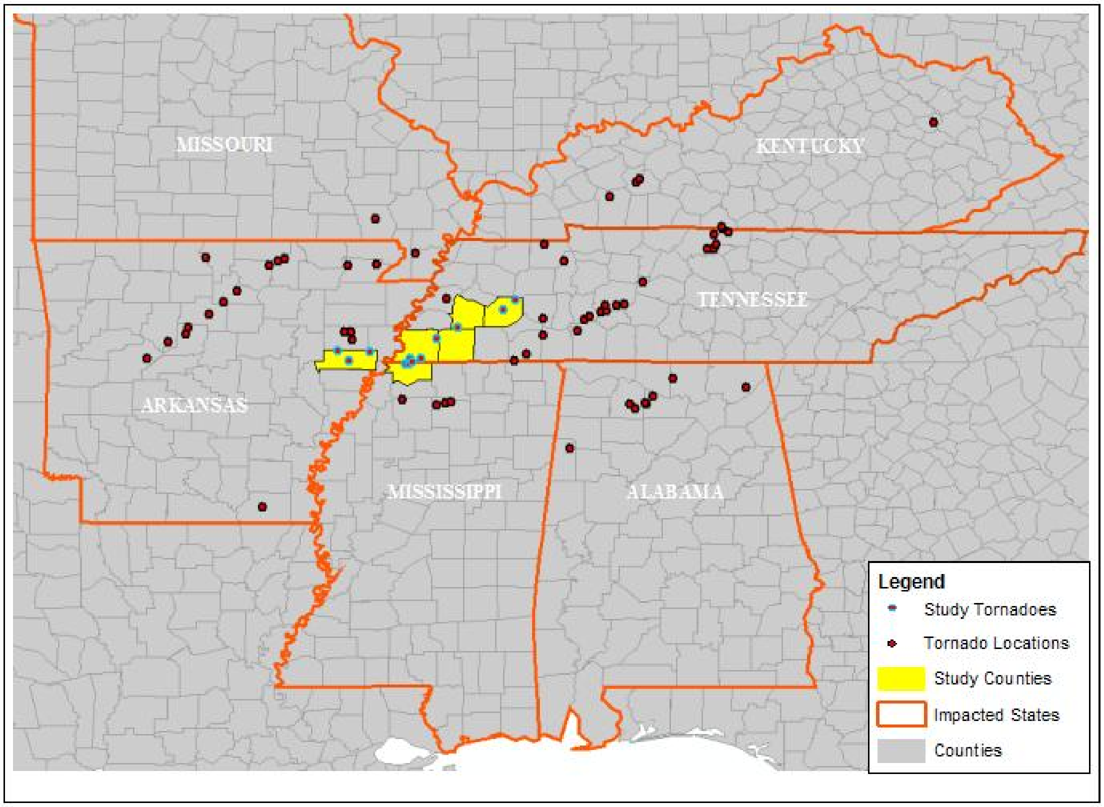

Figure 4. Huntersville, Tennessee

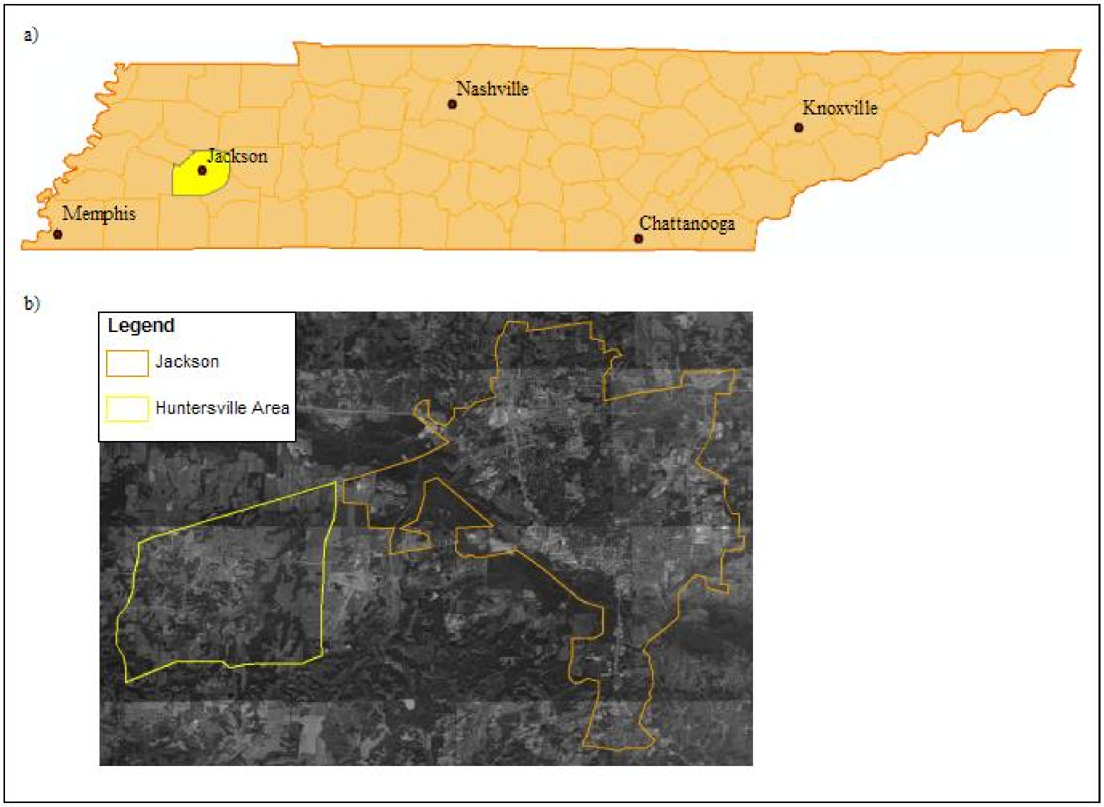

Figure 5. The SVAS Browser: An Example from Huntersville, Tennessee